8-5   The student will demonstrate an understanding of the effects of forces on the motion of an object. (Physical Science)

Key Concepts
Motion: motion, position, reference point, direction, speed, time-distance graph,
Average speed: $v=d/t$**,** total distance, total time, real-world problems
Effect of Forces: gravity, friction, force, mass, magnitude, balanced and unbalanced forces
Inertia

Supporting Content Web Sites

Mr. Mont's Teacher's Lounge: Crash Test Simulator
http://www.mrmont.com/games/crashtest.html
An interactive site that allows students to alter the results of the crash simulation by changing the speed and the mass of the vehicle.
8-5.4

NCTM: Graphing Runners
http://standards.nctm.org/document/eexamples/chap5/5.2/index.htm#APPLET
Two runners can be manipulated to design a race by changing the stride of the runners and their starting positions. When the program is started, students watch as a distance-time graph evolves that represents the speed of each runner.
8-5.1

PBS Online: The Race
http://teacherline.pbs.org/teacherline/resources/activities/race/readings/race.htm
Introductory page provides a link to an applet that initiates a race among three runners, each of whom moves at a different speed. Graphs are generated as the race develops, students can compare the graphs of actual and average speed for each runner, then calculate the speeds using data from the graph.
8-5.1, 8-5.2

Fear of Physics: Friction
http://www.fearofphysics.com/Friction/frintro.html
In this test of driver decision making, students are provided information about the physics of friction then directed to an animation of a traffic jam. The mass of the vehicle, the type of surface (dry, wet, snowy, icy), and the braking distance can be manipulated to determine the conditions necessary to avert a rear-end collision.
8-5.3, 8-5.4

Engineering Interact: Gravity
http://www.engineeringinteract.org/resources/parkworldplot/flash/concepts/gravity.htm
This animation explains gravity in examples on Earth and in space by emphasizing relative masses and balanced/unbalanced forces. Students make predictions then test them; when predictions are not correct, an explanation and redirection are provided.
8-5.3, 8-5.4, 8-5.5

Exploratorium: Skateboard Science
http://www.exploratorium.edu/skateboarding/trick.html
A multi-frame illustrated web-text about the forces of friction and gravity acting on a skateboarder. Photographs show skateboard tricks in freeze-frame action and the text explains the forces involved and the tricks-of-the-trade for accomplishing the feat.
8-5.3, 8-5.4, 8-5.5, 8-5.6

PBS On-line: Building Big Skyscraper Basics
http://www.pbs.org/wgbh/buildingbig/skyscraper/basics.html
Students are provided background information on the structure of skyscrapers, and then are directed to several engineering problems involving skyscrapers. Students must use their knowledge of gravity and balanced and unbalanced forces to determine the correct solution.
8-5.4, 8-5.5

PBS On-line: Building Big Shapes Lab
http://www.pbs.org/wgbh/buildingbig/lab/shapes.html
An interactive opportunity for students to test the strength and observe the directional forces on shapes used in architecture. When the shape is tested for strength, students are shown how to reinforce it, and are directed to do a comparison of increasing mass to determine which structure is the strongest.
8-5.4, 8-5.5

Athens Academy: The Truck and Ladder
http://www.geocities.com/Athens/Academy/9208/il.html
This animation is accompanied by a thorough explanation of inertia and the motion of a car, a truck, and a ladder in a rear-end collision.
8-5.6

Suggested Literature

Macaulay, D. (2000). *Building big.* Boston, MA: Houghton Mifflin.
ISBN: 0395963311
Lexile:
In this celebration of engineering, detailed, labeled cut-away drawings illustrate the forces that architects and engineers must consider when designing and building large structures such as domes, bridges, skyscrapers, tunnels, and dams. The examples used are actual structures such as the Hoover Dam, the Channel Tunnel, and the Golden Gate Bridge.
8-5.5, 8-5.6

Fullick, A. (2004). *Under pressure: forces.* Portsmouth, NH: Heinemann Library.
ISBN: 1403448183
Lexile: not available
In its description of everyday situations that are familiar to students, this book illustrates gravity, friction, balanced and unbalanced forces in a format that includes detailed captions, diagrams, and strange-but-true facts.
8-5.3, 8-5.4, 8-5.5

Doherty, P., Rathen, J. et al. (1996). *The spinning blackboard and other dynamic experiments on force and motion.* Indianapolis, IN: Jossey-Bass.
ISBN: 0471115142
Lexile: not available
Includes over 20 experiments and demonstrations from the Exploratorium that can be performed by students at home using materials that are relatively easy to locate. The procedures are easy-to follow and are accompanied by a thorough explanation of the concepts, which include inertia, gravity, and balance and unbalanced forces. Some content is beyond the scope of the 8th grade curriculum, but would be interesting introductions for advanced students.
8-5.3, 8-5.4, 8-5.5, 8-5.6

Riley, P. (2000). Science topics: forces and motion. Portsmouth, NH: Heinemann Library.
ISBN: 1575727722
Lexile: Not available
The detailed diagrams, illustrations, photographs, fact boxes, and side bars provide explanations of the relationship between weight and gravity, the different types of friction, the relationship between mass and speed, and how force is measured. Also includes do-at-home activities so students can experience the concepts.
8-5.3, 8-5.4, 8-5.5, 8-5.6

Sauvain, P. (1992). *Motion (the way it works)*. New York, NY: Macmillan.
ISBN: 0027810771
Lexile: not available
Defines motion and relates it to escalators and other machinery.
8-5.3, 8-5.4, 8-5.5, 8-5.6

Lafferty, P. (2001). *Forces and motion.* Austin, TX: Raintree Steck-Vaughn.
ISBN: 0739810073
Lexile: Not available
Rich in detailed drawings, charts, and diagrams, this book contains several other components to provide students with opportunities to learn more through research. Sections include side-bars of interesting facts, biographical insights, and insights about the future of the study of forces and motion.
8-5.1, 8-5.2, 8-5.3, 8-5.4, 8-5.5, 8-5.6

Salvadori, M. G. (2002). *Why buildings stand up: the strength of architecture.* New York, NY: W. W. Norton Company.
ISBN: 0393306763
Lexile: not available
A structural description of significant buildings in the world and the forces and technology that keep them upright. This book would be especially appreciated by students who have an interest in history, architecture, art, engineering, or construction.
8-5.3, 8-5.4, 8-5.5, 8-5.6

Levy, M. & Salvadori, M. G. (2004). *Why buildings fall down: how structures fail*. New York, NY: W. W. Norton Company.
ISBN: 039331152X
Lexile: not available
As a companion to *Why Buildings Stand Up*, this book completes the cycle of engineering problem solving. The structural flaws that contributed to the unbalanced forces of the collapsed structures are accompanied by suggestions of how those flaws could have been averted. Some structural failures are attributed more to human error and poor decision making than to mechanical failure.
8-5.3, 8-5.4, 8-5.5, 8-5.6

Suggested Streamline Video Resources

The Ups and Downs of Technology
Constant Motion
ETV Streamline SC
An explanation of the forces acting on a racing cyclist and a sky diver uses on screen force arrows and speedometer to help students see how motion changes due to the forces of gravity and friction. Includes a description of the how the athletes make adjustments to balance forces in order to maintain constant speed.
Segment 4: 6:26
8-5.3, 8-5.4, 8-5.5

Physical Science: Forces and Gravity
ETV Streamline SC
Segment 1: Introduction to Forces and Gravity (3:18)
Segment 2: Friction (3:10)
A very good conceptual overview of the laws governing the motion of an object in vivid action-packed examples from the world of sports, architecture, and recreation. The segment includes descriptions of balanced and unbalanced forces, gravity, inertia, and friction ending with the technology of space transportation.
0:00-6:28
8-5.3, 8-5.4, 8-5.5, 8-5.6

Physical Science: Forces and Gravity
Segment 5: Forces at Work in an Amusement Park (3:00)
ETV Streamline SC
Provides examples of inertia and gravity in amusement park rides. Also includes a discussion of centrifugal and centripetal forces which are beyond the scope of this standard.
8-5.3, 8-5.6

Basics of Physics: Exploring the Laws of Motion
Segment 2: Newton's First Law of Motion: Force, Friction, and Inertia (4:40)
ETV Streamline SC
Illustrates the concept of inertia through several demonstrations including the table cloth trick and penny-in-a-cup and explains the relationship of gravity and friction to the inertia and motion of an object. Key concepts and definitions are displayed in large type on the screen as they are introduced. Explanations that accompany the remaining demonstrations in this segment contain anthropomorphism and should be avoided.
8-5.3, 8-5.4, 8-5.5, 8-5.6

Mathematical Eye: Measurement
Segment 5: Measuring Speed (4:34)
ETV Streamline SC
Shows the unique way British law enforcement officers measure the speed of a motorist using the distance between two bridges, and then presents students a problem for determining the speed of the flow of a river. The latter provides a good opportunity to design an inquiry that includes the best procedure for controlling variables and obtaining the most accurate data.
8-5.2

Discovering Math: Concepts in Algebra
Segment 2: Speed of a Car (3:30)
ETV Streamline SC
Explains the variables in the equation for speed, indicates the placement of the variables in a data table, and illustrates the correct placement of these variables on a distance-time graph. The constant motion of a car is graphed and used to calculate the speed of the car.
8-5.1, 8-5.2

Discovering Math: Concepts in Algebra
Segment 3: Speed of a Bungee Jumper (1:42)
ETV Streamline SC
The distances and times from three bungee jumps are used to calculate the average speed of the jumper. The average speed graph that results is shown.
8-5.1, 8-5.2

Simply Science: Energy Transformations
Segment 4: A Graphic Illustration (4:47 min)
ETV Streamline SC
Discusses the design of a distance-time graph to determine the speed of an elevating bucket in a grain silo, including the correct placement of the variables and using a line of best fit for the data. Also shows how the slope of the line formed is used to calculate the speed of the conveyor belt and considers how plotting two lines on the same graph could be used to determine the comparative speed of two objects. Best used with students who have had or are taking Algebra I and can understand more advanced algebra applications.
8-5.1, 8-5.2

Career Connections

Air traffic controller
Air traffic controllers use radar and visual observation to organize the flow of planes traveling through an airport's airspace by controlling the speed of the planes and the distance between them. They also keep pilots informed of weather changes such as wind shear (sudden change in velocity of the wind).

Architect
Architects design the overall aesthetics and structure of a building, prepare drawings of all the structural systems, and specify the building materials that will support the design by counteracting forces acting on it.

Athletic trainer
Athletic trainers, under the supervision of a licensed physician, utilize an understanding of forces and biomechanics to prevent and treat musculoskeletal injuries by advising people on the correct use of training equipment and body posture.

Failure analysis engineer
This specialized engineer recreates a system malfunction or catastrophic structural failure to determine what happened, and then recommends needed changes to avoid having the problem occur again. Crash test engineers belong in this category.

Robotics technician
Robotics technicians work in industrial settings to install, service, maintain, troubleshoot, and repair robots and automated production systems through an understanding of the way the robots were designed to move and the forces such as friction that might create wear on the moving parts.